



# Emerging Indicators of Human and Climatically- Induced change in Coastal Ecosystems

Hans Paerl, UNC-CH Institute of Marine Sciences  
Morehead City, NC [www.marine.unc.edu/Paerllab](http://www.marine.unc.edu/Paerllab)

[www.aceinc.org](http://www.aceinc.org)

With lots of help from:

Nathan Hall

Larry Harding

Ed Houde

Alan Joyner

Dave Kimmel

Rick Luettich

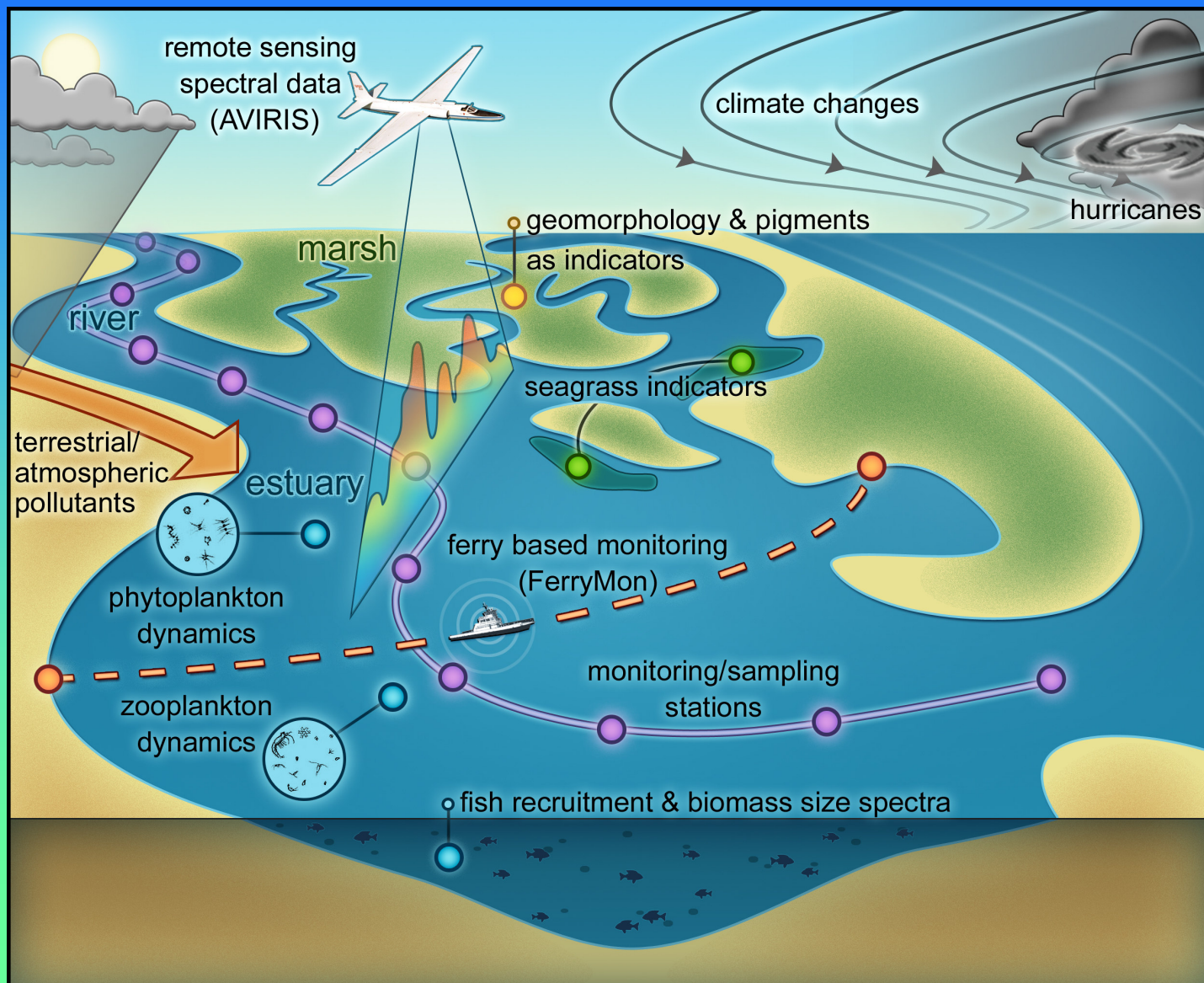
Ben Peierls

Jay Pinckney

Karen Rossignol

Lexia Valdes-Weaver

& many Others



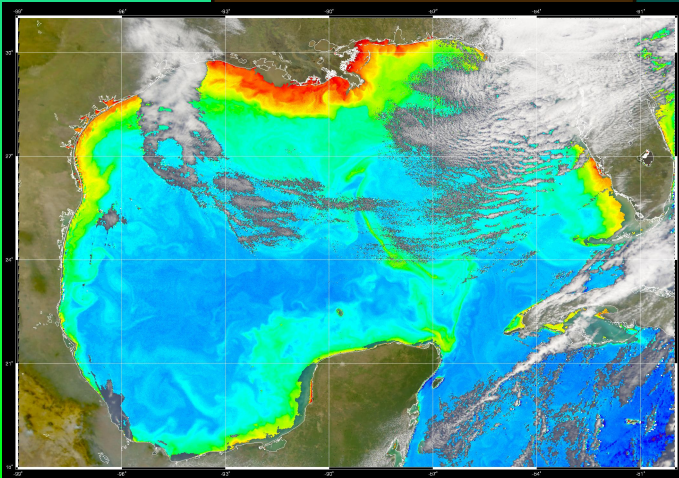
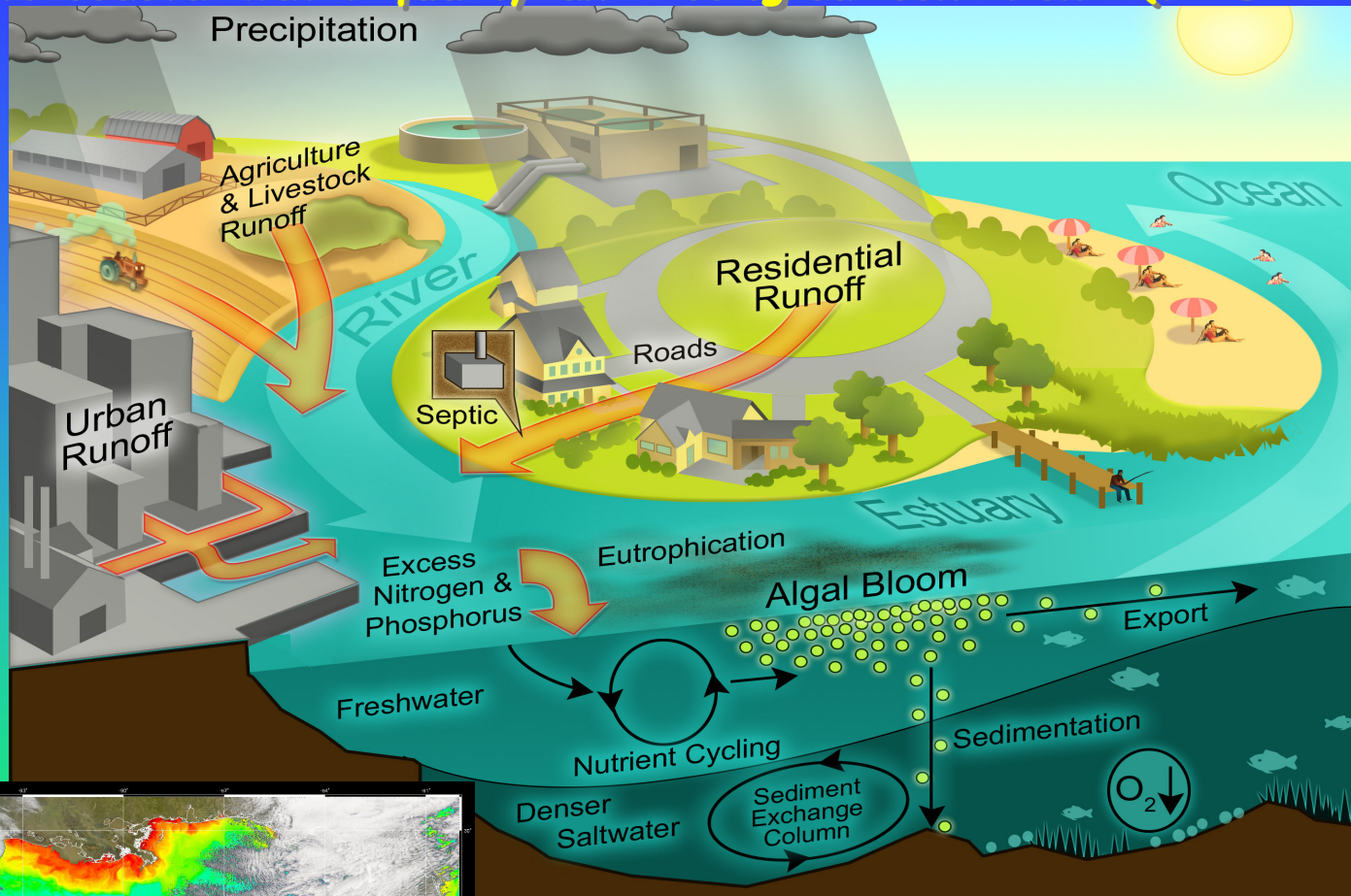


# Regional & national coastal indicators for assessing ecosystem responses to anthropogenic and naturally-induced change

## What should they do?

- **Detect, quantify and predict ecosystem change for a range of estuaries varying in trophic state and water residence time**
  - **Clarify processes underlying change**
- **Evaluate human vs. natural impacts on WQ and habitat conditions**
  - **Complement environmental monitoring and assessment tools**  
**Examples (only enough time for some bio-indicators)**
    - **Plant/productivity-based indicators**
      - **Trophodynamic indicators**
    - **Remote sensing for “scaling up”**
- **Be available and useful to WQ/habitat management agencies**

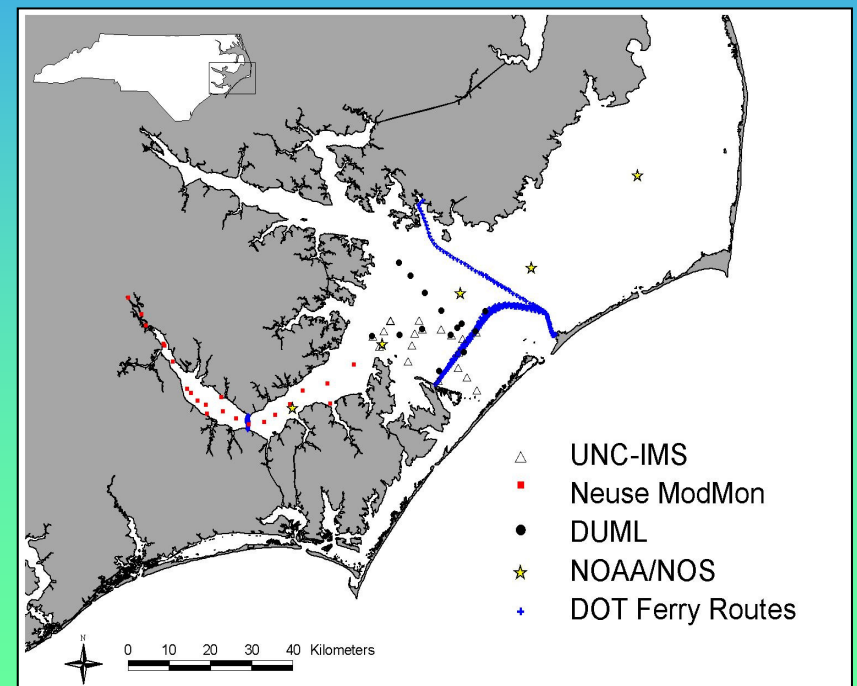
# Assessing nutrient over-enrichment: "The most rapidly-expanding threat to coastal water quality and ecological condition" (NAS 2000)



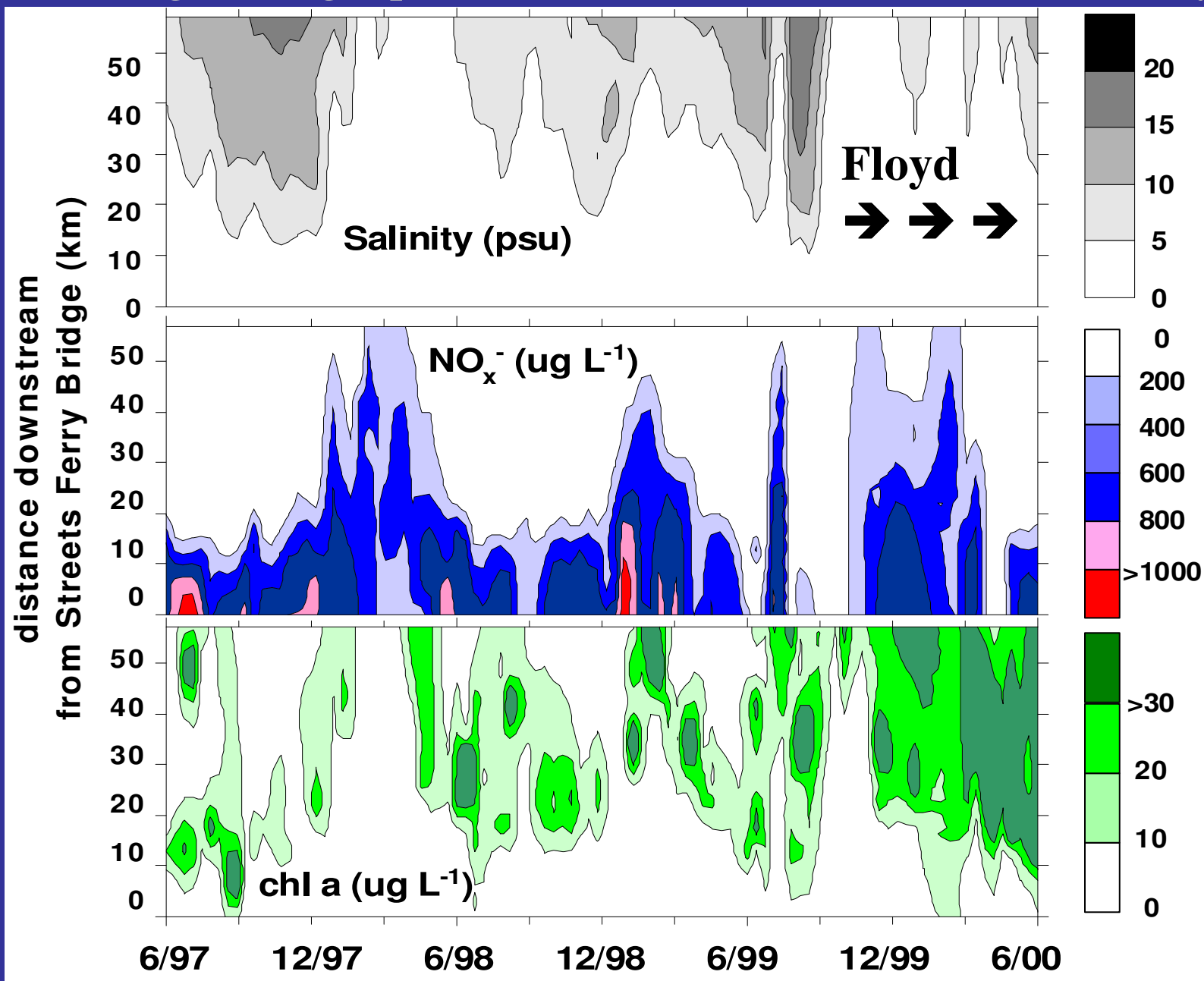


## Example: Neuse River Estuary-Pamlico Sound

Excessive N loading → eutrophication → hypoxia → WQ/habitat decline



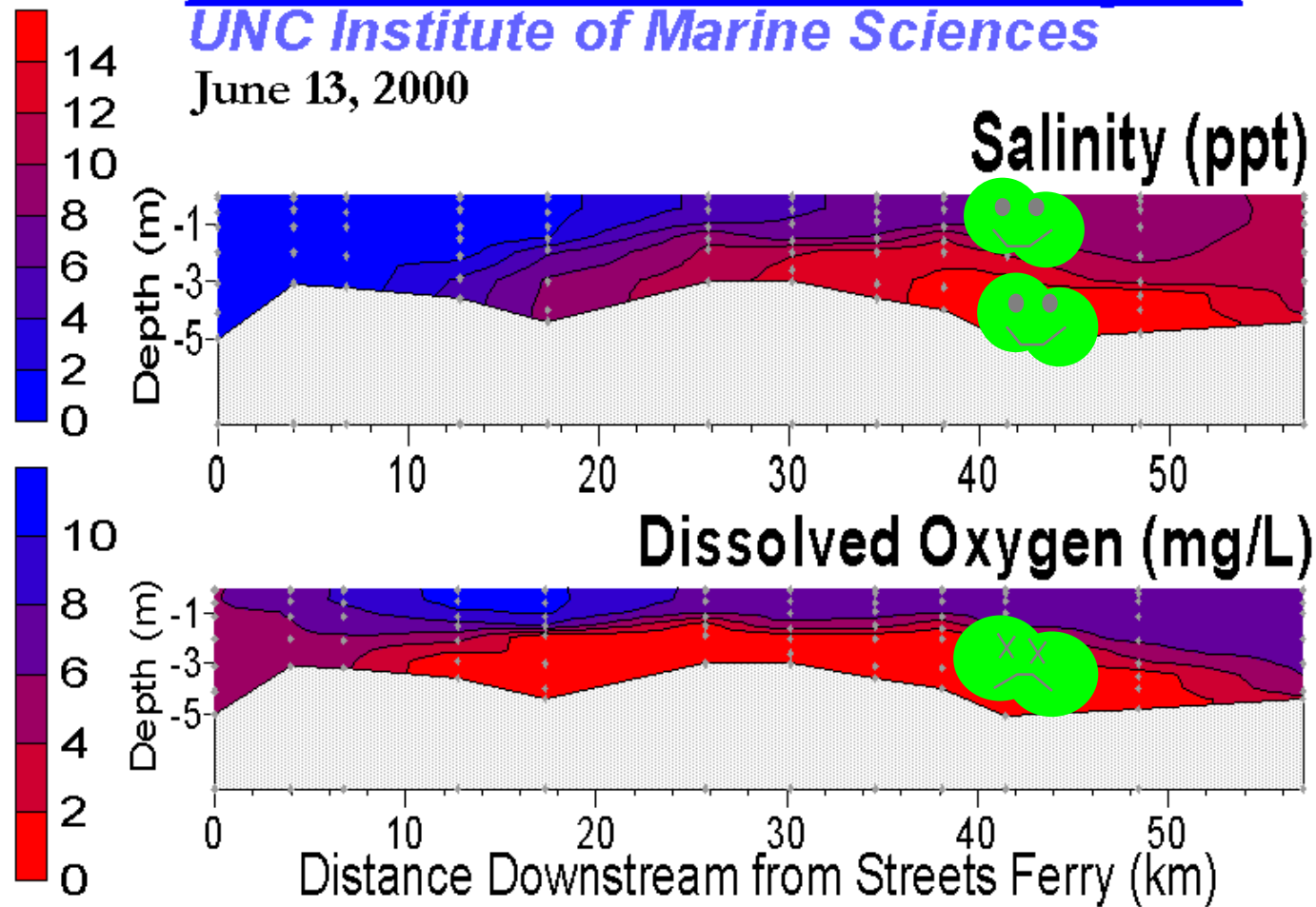
# N loading and algal production (Chl a) in the Neuse R. Estuary



## The connection to Hypoxia

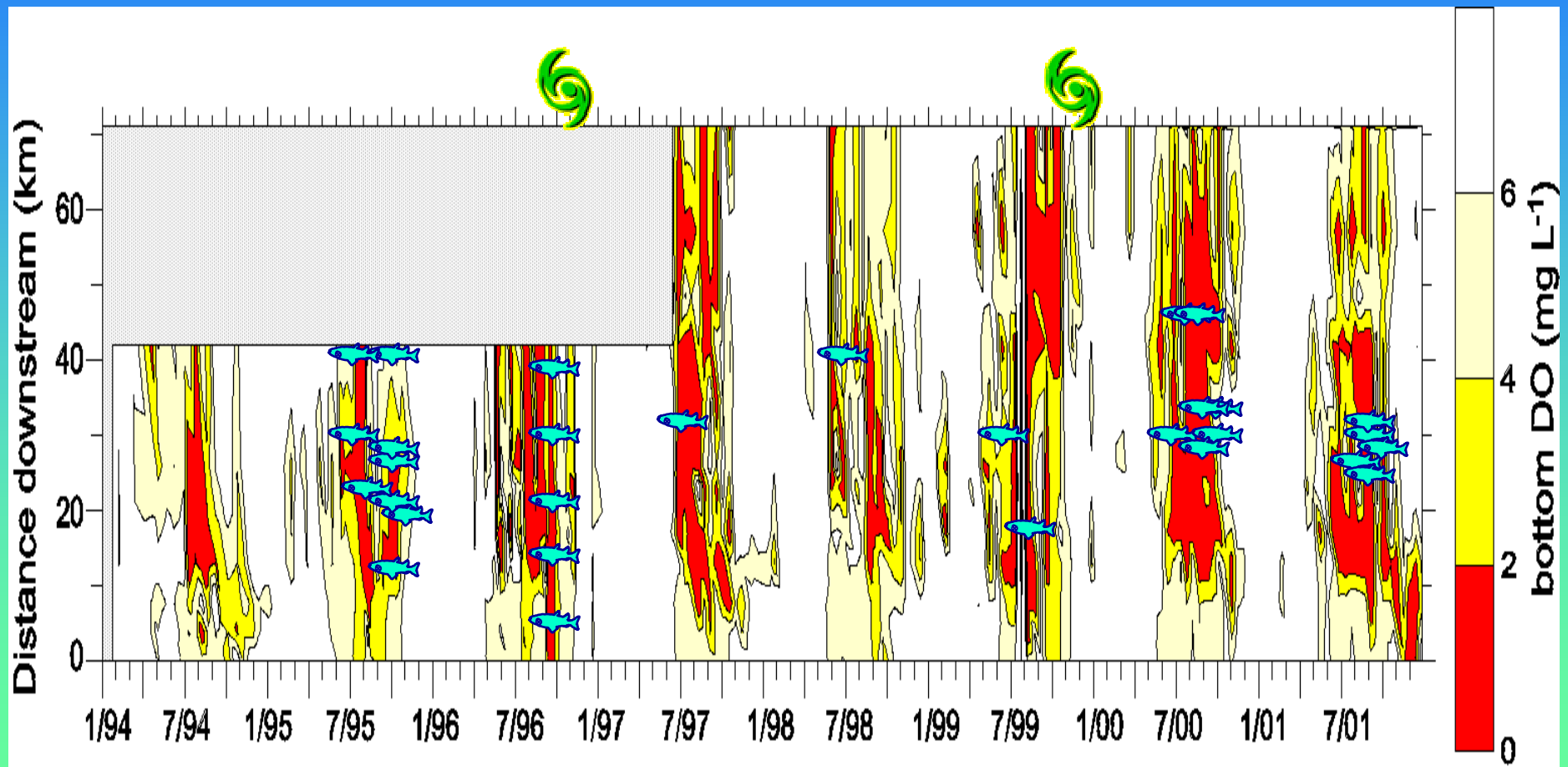
### Neuse River MODMON Project UNC Institute of Marine Sciences

June 13, 2000



# Hypoxia and Fish kills in the Neuse River Estuary 1994-2001

Data Sources: ModMon Project & NC DENR-DWQ



Fish kill data base: <http://www.esb.enr.state.nc.us:80/Fishkill/fishkillmain.htm>

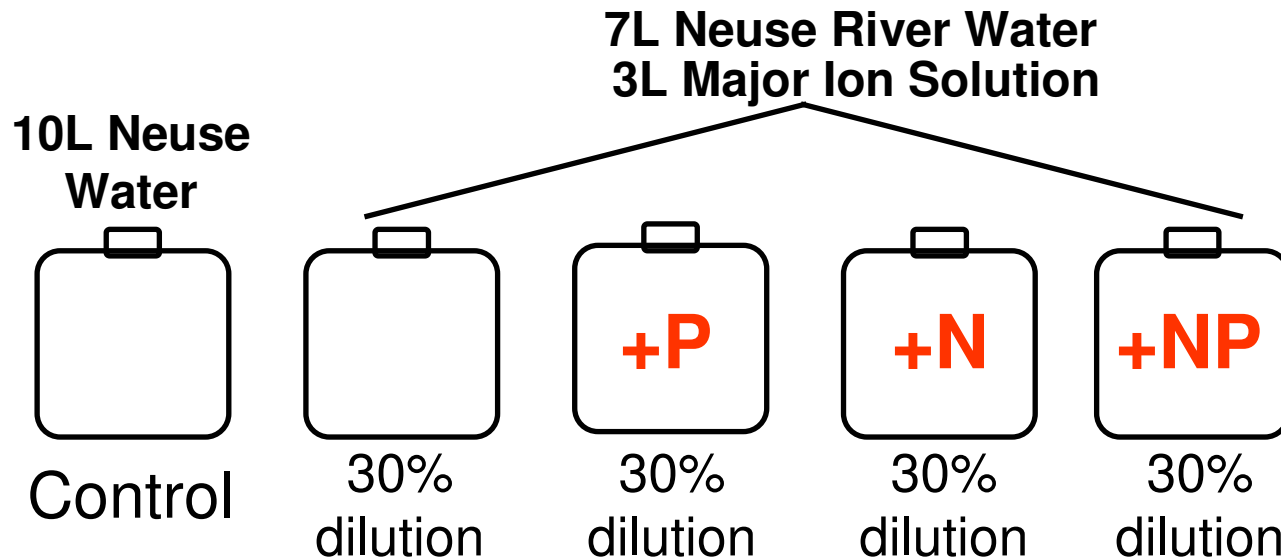
**Need:** Reduce Estuarine Primary Production  
(Chl *a*) by Establishing an N Input Threshold

**Scientific Consensus/Recommendation:**  
30% N Input Reduction (based on 1990-1995 loads)

**Indicator:** Using photopigments to assess  
algal growth response to N reductions (i.e.  
mandated 30% N input reduction = TMDL)



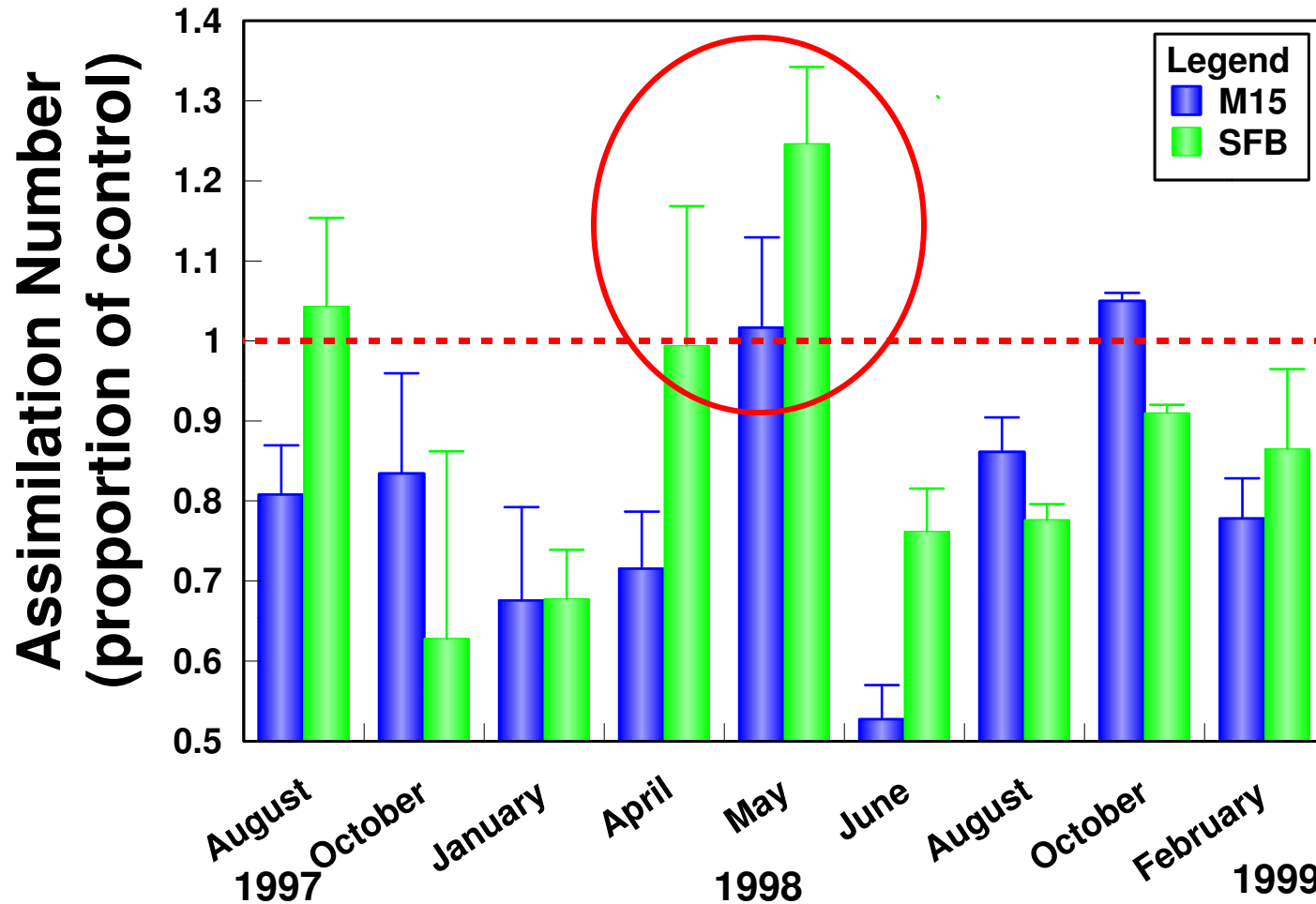
# Asking the **Phytoplankton**: Dilution Bioassays



Response Indicators:

**Chl *a***, primary productivity

## Seasonal Effect of 30% Reduction in N Concentration 84 Hour Incubation



Piehler et al. 2001